Directed and Elliptic Flow in Pb+Pb collisions at 40 and 158 AGeV[1]

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Directed and elliptic flow measurements for charged pions and protons are reported as a function of transverse momentum, rapidity, and centrality for 40 and 158 A·GeV Pb + Pb collisions as recorded by the NA49 detector. Both the standard method of correlating particles with an event plane, and the cumulant method of studying multiparticle correlations are used. In the standard method the directed flow is corrected for conservation of momentum. In the cumulant method elliptic flow is reconstructed from genuine 4, 6, and 8-particle correlations, showing the first unequivocal evidence for collective motion in A+A collisions at SPS energies.

The results from the standard method integrated over centrality weighted with the fraction of the geometric cross section for each bin are shown in Fig. 1.
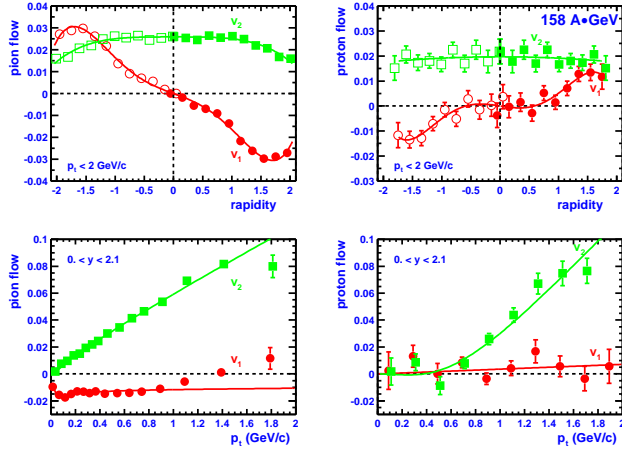

FIG. 1: Standard minimum bias directed and elliptic flow as a function of rapidity (top) and transverse momentum (bottom) for charged pions (left) and protons (right) from 158 A·GeV Pb + Pb. Shown are v_1 (circles) and v_2 (squares). The open points in the top graphs have been reflected about midrapidity. Solid lines are polynomial fits on the top and Blast Wave model fits on the bottom.

Results from the standard method for the doubly-integrated v_n as a function of centrality are shown in Fig. 2. These results were obtained by averaging the tabulated $v_n(p_t, y)$ val-

ues, over both transverse momentum and rapidity, using the cross sections as weights. For pions on top, the values generally increase in absolute magnitude in going from central to peripheral collisions. However, for protons on bottom, the values appear to peak at mid-centrality.

The energy dependence of v_2 is roughly linear from AGS up to RHIC energies. No indication of non-monotonic behavior is visible, as would be expected from the softening of the equation of state for a system close to the critical temperature. The dependence of elliptic flow (divided by the eccentricity of the nuclear overlap region) on particle (rapidity) density also
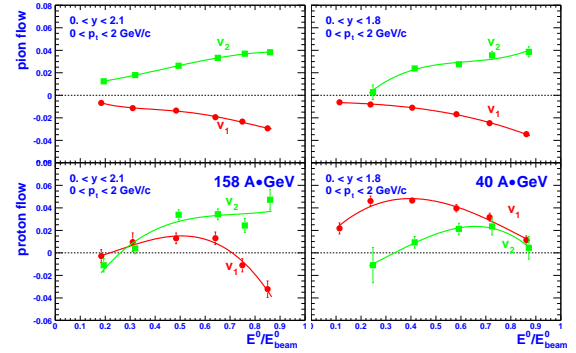

FIG. 2: Directed and elliptic flow as a function of centrality for charged pions (top) and protons (bottom) from 158 A·GeV Pb + Pb (left) and 40 A·GeV Pb + Pb (right) from the standard analysis. Shown are v_1 (circles) and v_2 (squares). The more central collisions are on the left side of each graph. Solid lines are polynomial fits.

exhibits a smooth increase without significant structure which would indicate a change in the physics of rescattering.

[1] Condensed from "Directed and elliptic flow of charged pions and protons in Pb + Pb collisions at 40 and 158 A·GeV", C. Alt *et al.*, to be published Phys. Rev. C (2003).